VSTOL Ground Effects Characterization and Control

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Research Objective: Develop and validate a numerical method using computational fluid dynamics (CFD) for the prediction of VSTOL ground effects flow fields. Use the validated computational prediction method to explore flow control devices designed to limit lift loss due to suckdown and hot gas ingestion and to limit landing area heating and acoustic levels.

Methodology: Two CFD approaches were explored with two different CFD codes, USM3D and Overflow, which use unstructured and chimera-structured grids, respectively. The CFD codes were validated against existing experimental data including simple flat plate studies and more complex multiple jet delta wing studies. The approach that shows the best agreement with experimental data will then be used to explore various control device concepts designed to reduce or eliminate the adverse characteristics associated with VSTOL aircraft flight in ground effect.

Results: Initial comparisons with experimental data for simple flat plate cases showed promising results, fig. 1. Comparison with experimental data for the more complex delta wing case has not yet been completed. Surface pressure results, fig. 2, and Mach contours along the symmetry plane, fig. 3, from the Overflow code indicate all the expected features such as the fountain effect between the two jets.

Significance: A validated CFD tool is essential for the expedient and accurate prediction of forces and moments experienced by a VSTOL aircraft flying in ground effect. A validated computational method would also greatly reduce design cycle time and cost by providing a fast and reliable test bed for parametric design changes. Ground effect flow control devices have the potential to greatly affect all of the following areas: thrust and fuel requirements for take off and landing, aircraft stability, landing area erosion, ground crew safety, etc.. This, in turn, has the potential to significantly reduce overall life cycle cost.

JWCO: Precision Force

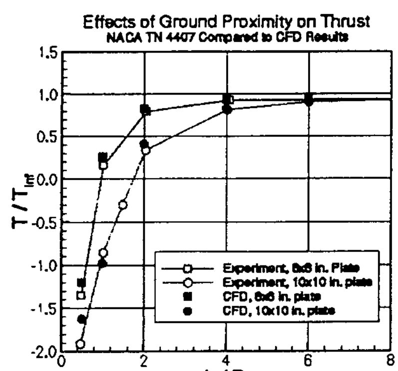

Fig 1. Comparison of CFD with experimental suckdown data. Courtesy LMTAS

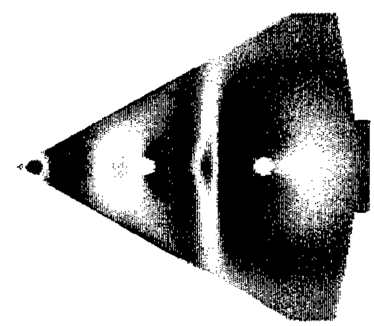

Fig 2. Pressure contours on the lower surface

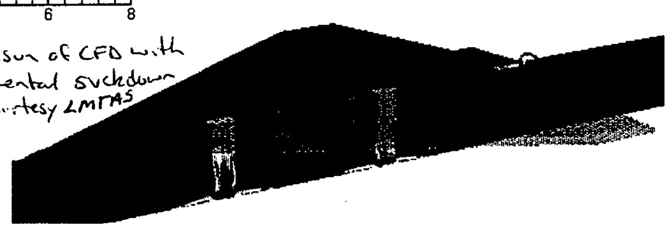

Fig. 3 Mach contours along the symmetry plane

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